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SOME ASPECTS OF THE LIFE HISTORY OF RAZOR CLAMS <u>Siliqua patula</u> (Dixon) IN COOK INLET, ALASKA

By:

John C. McMullen
Division of Sport Fish
Soldotna, Alaska

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SOME ASPECTS OF THE LIFE HISTORY OF RAZOR CLAMS *Siliqua patula* (Dixon) IN COOK INLET, ALASKA

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John C. McMullen, Fishery Biologist
Alaska Department of Fish and Game
Division of Sport Fish
Soldotna, Alaska

INTRODUCTION

Razor clams *Siliqua patula* (Dixon) are found on many surf-swept, sand beaches of southcentral Alaska. Many of these beaches, popular for the sport harvest of razor clams, are located along the eastern shore of Cook Inlet.

An earthquake of 8.5 intensity on the Richter Scale occurred in southcentral Alaska on March 27, 1964. A 68,310 square mile area subsided (Plafker, 1965), including the Kenai Peninsula and Cook Inlet. Subsidence plus recent increased effort by sport diggers prompted a study of razor clams on Cook Inlet beaches adjacent to the Kenai Peninsula road system. This paper discusses some findings on the first year's study.

Description of the Area

The beach areas studied extend from the Kasilof River to Anchor Point. This area lies along the southwestern part of the Kenai Peninsula. The principal areas of study are Clam Gulch and Deep Creek, which are 22 and 45 miles, respectively, south of Soldotna on the Sterling Highway (Figure 1).

Clam Gulch beaches are of low gradient and are composed of fine sand, clay and gravel. On an extreme low tide of minus five feet, clam beds 300 feet in width may be exposed. The more southern beaches in the Deep Creek area are of a high gradient and consist almost entirely of coarse, white sand. Extreme low tides expose clam beds of less than 100 feet width with limited digging area.

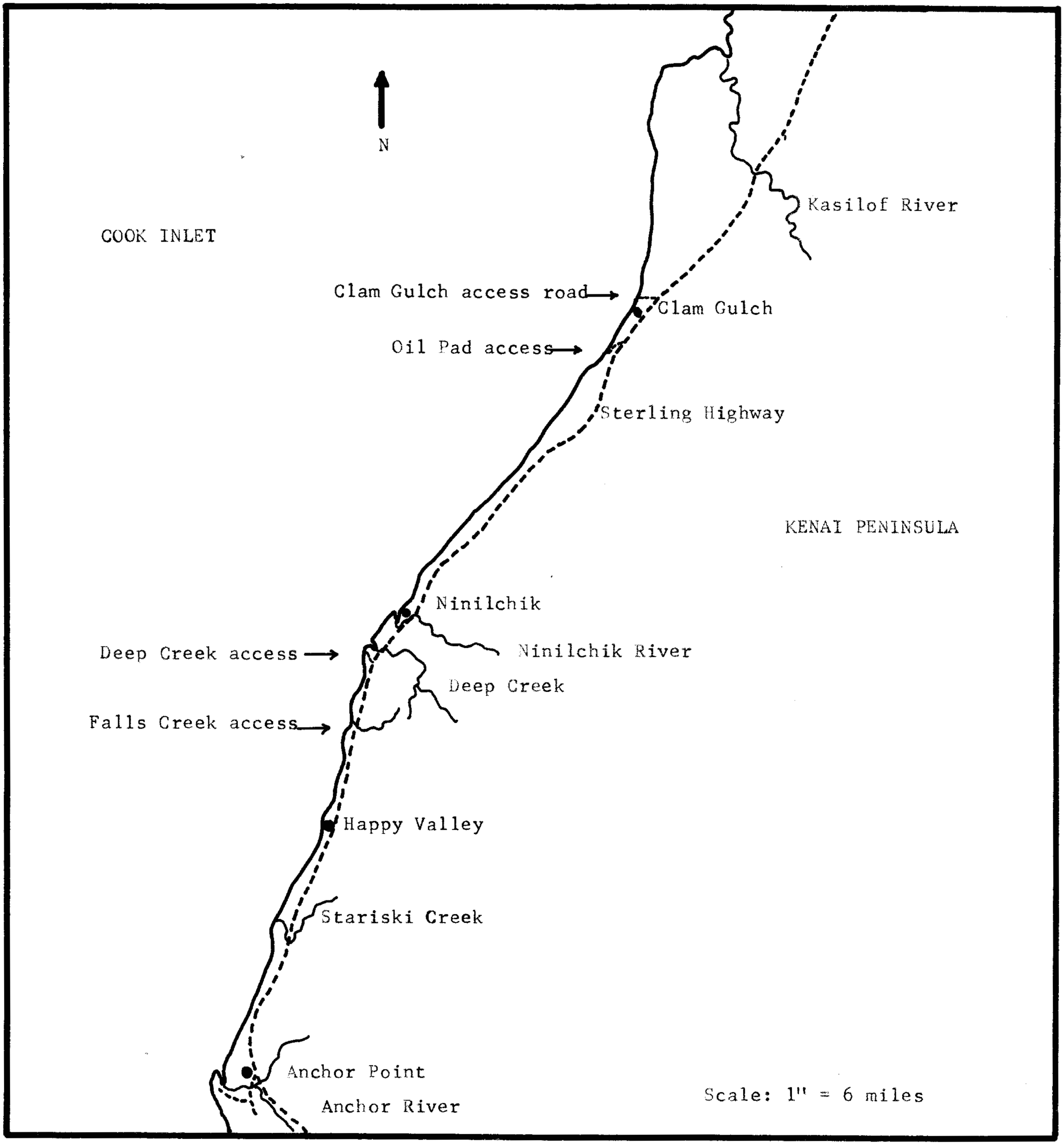

Figure 1. Map of southwestern Kenai Peninsula listing access points.

Life History

Female razor clams annually produce 6 - 10 million eggs. Spawning occurs when spring or summer rising water temperatures reach 55° F. (Weymouth, 1925). Eggs are broadcast through the clams' excurrent siphons to be fertilized in the surf by sperm which are ejected in a like manner.

Larvae, upon hatching, are ciliated and free swimming veligers for 5 - 16 weeks (Oregon Fish Commission, 1963). After passing through the veliger stage small clams develop a shell and sink to the bottom. Those remaining along favorable beaches will "set" into the top layer of sand upon reaching an average shell length of about 13 mm. (Tegelberg, 1964). Young clams grow slowly throughout the fall and winter. Warming waters and increased food supply accelerate spring growth, which continues at a rapid pace throughout the summer.

Slow winter growth is characterized by the dark coloration of the shell formed during this period. More rapid summer growth is represented by light green areas of the shell. Since shell size increases by the addition of material to its margin, winter and summer growth appear as a series of rings. Shell areas of winter growth may be designated as annual growth rings. With practice, clams can be aged by counting these rings.

Razor clams will measure approximately 100 mm shell length in two or more years, with faster growth being characteristic of specimens of the northwest states. Sexual maturity compliments this length. Mature razor clams will then spawn when appropriate environmental conditions are met.

YOUNG OF THE YEAR RAZOR CLAMS

The presence of razor clams in the 30 - 40 mm size range was first noted at Clam Gulch, Alaska in April, 1965. They are thought to be 1964 year class clams, because no smaller clams were found during the 1965 growing season. Monthly collections of this age class produced new growth data which aid in the aging of larger razor clams and the timing of their entry into the sport fishery.

A sample of young razor clams of uniform dark green color was collected on May 19, 1965. Two distinct size groups with means of 30.4 and 47.7 mm were represented. Hirschhorn (1962) attributes this phenomenon to unequal setting dates of Oregon clams. The bimodal length distribution is present in all samples of 1964 year clams collected during the summer of 1965. Light green shell margins of razor clams collected June 15, 1965 indicated that accelerated growth had begun.

Total 1965 summer growth and monthly increments of growth are calculated for 1964 year class clams (Table 1, Figure 2). As shown by the increments of growth, the most rapid growth period extended from June 15 to August 1. One sample mean of 76.6 mm is recorded in Table 1, while the corresponding mean in Figure 2 is graphed as 79.0 mm. The graphed means are found by adding monthly increments of growth, while the means presented in Table 1 are those of the individual samples.

Shown also in Figure 2 is the first year's growth of a group of comparable age Oregon clams (Hirschhorn, 1962). Warmer waters and a more abundant food supply may account for the more rapid growth of Oregon razor clams.

GROWTH OF COOK INLET RAZOR CLAMS

An age and growth study by Weymouth, et. al. (1925) included razor clams of Cordova and Swikshak, Alaskan beaches. Their data indicate that razor clams studied did not reach a harvestable length of 100 mm until their sixth and fifth years of life, respectively. Data collected at Clam Gulch during the summer of 1965 indicate that the growth rates of Cook Inlet razor clams may be greater than those previously determined for Alaskan clams. The growth of five age classes is presented in Table 2, and graphed in Figure 3 along with the growth curves of razor clams collected from Washington (Tegelberg, 1964), Oregon (Hirschhorn, 1962), and Swikshak, Alaska (Weymouth, et. al, 1925). The Clam Gulch specimens utilized in Table 2 are those which were aged with assurance. Washington and Oregon beaches produce 100 mm clams which have just begun their second full year of growth, whereas Clam Gulch beaches produce 100 mm clams which are in their third full year of growth.

One factor contributing to the seemingly slower growth of Swikshak, Alaska razor clams was Weymouth's (1925) designation of the first winter's (1_o) growth annulus as the first full year's (1_1) annulus. The growth curve for Swikshak and Clam Gulch razor clams might correspond more closely if similar aging methods were used.

Table 1. Average periodic increments of growth of two 1964 year class razor clam size groups, collected during 1965 at Clam Gulch.

Date 1965	Group	Number	Average total length mm	Average annulus length mm	Average growth mm	Increment of growth mm
May 17	A	34	30.4	-	-	-
" "	B	30	47.7	-	-	-
June 15	A	48	37.2	31.1	6.1	6.1
" "	B	17	49.9	44.2	5.7	5.7
July 3	A	11	46.5	34.0	12.5	6.4
" "	B	8	59.5	48.3	11.2	5.5
July 29	A	40	56.8	31.6	25.2	12.7
" "	B	24	69.4	46.1	23.3	12.1
August 28	A	31	63.8	30.2	33.6	8.4
" "	B	14	76.0	47.1	28.9	5.6
Sept. 24	A	12	69.2	31.1	38.1	4.5
" "	B	11	76.6	43.8	32.8	3.9

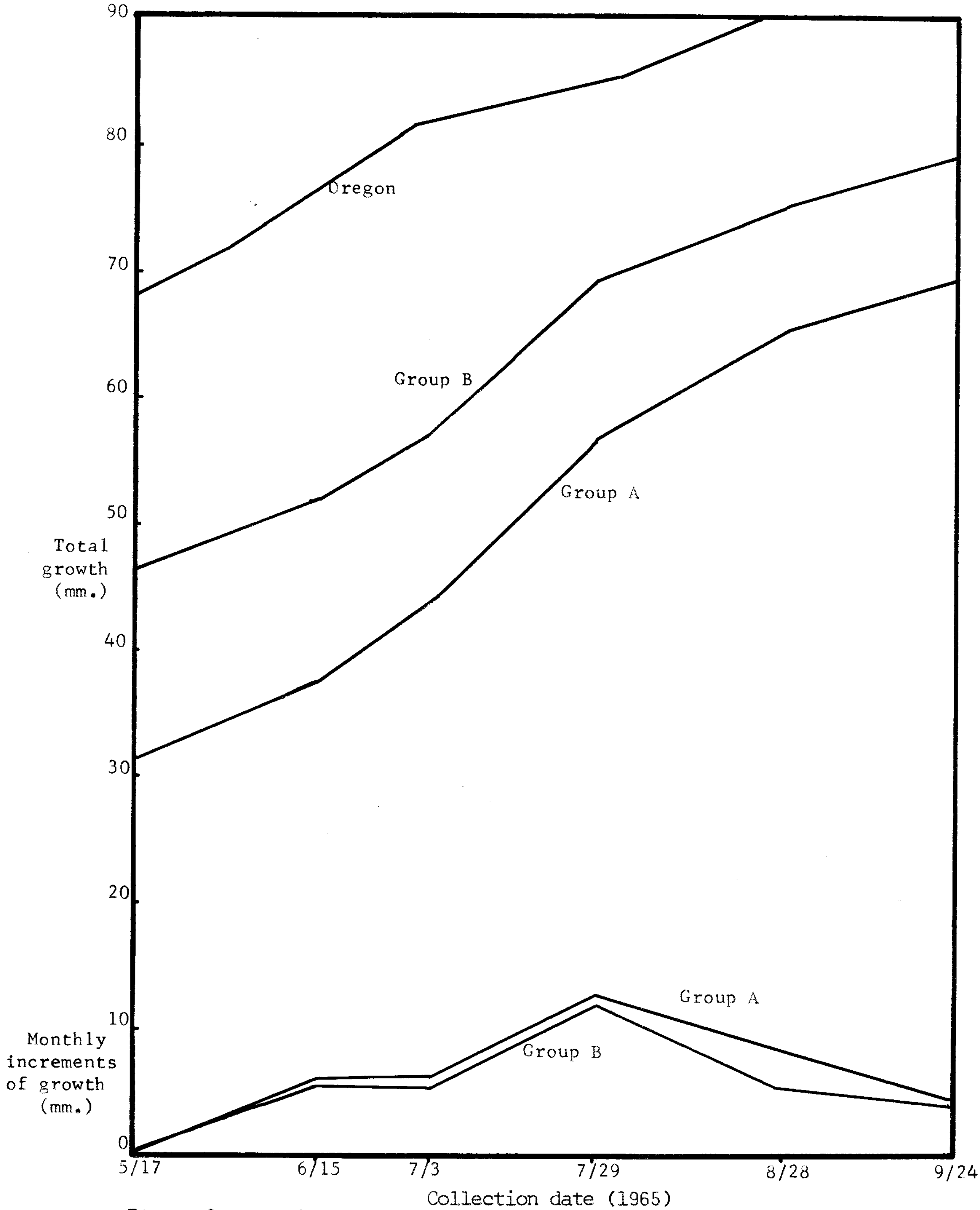

Figure 2. Total and increments of growth of the two size groups of 1964 year class Clam Gulch clams as compared with that of 1949 year class clams from Clatsop Beach, Oregon (Hirschhorn, 1962).

Table 2. Growths of five age classes of razor clams from Clam Gulch, Alaska, obtained by direct measurements of annual rings.

Year Class	Number	Average length of sample at annulus (mm)					
		1.	I	II	III	IV	V
1963	3	51.7	79.7				
1962	13	46.9	87.1	97.7			
1961	20	37.7	73.5	100.7	111.3		
1960	10	56.9	80.5	93.6	109.4	115.1	
1959	1	39.7	76.1	92.9	102.2	115.6	120.6

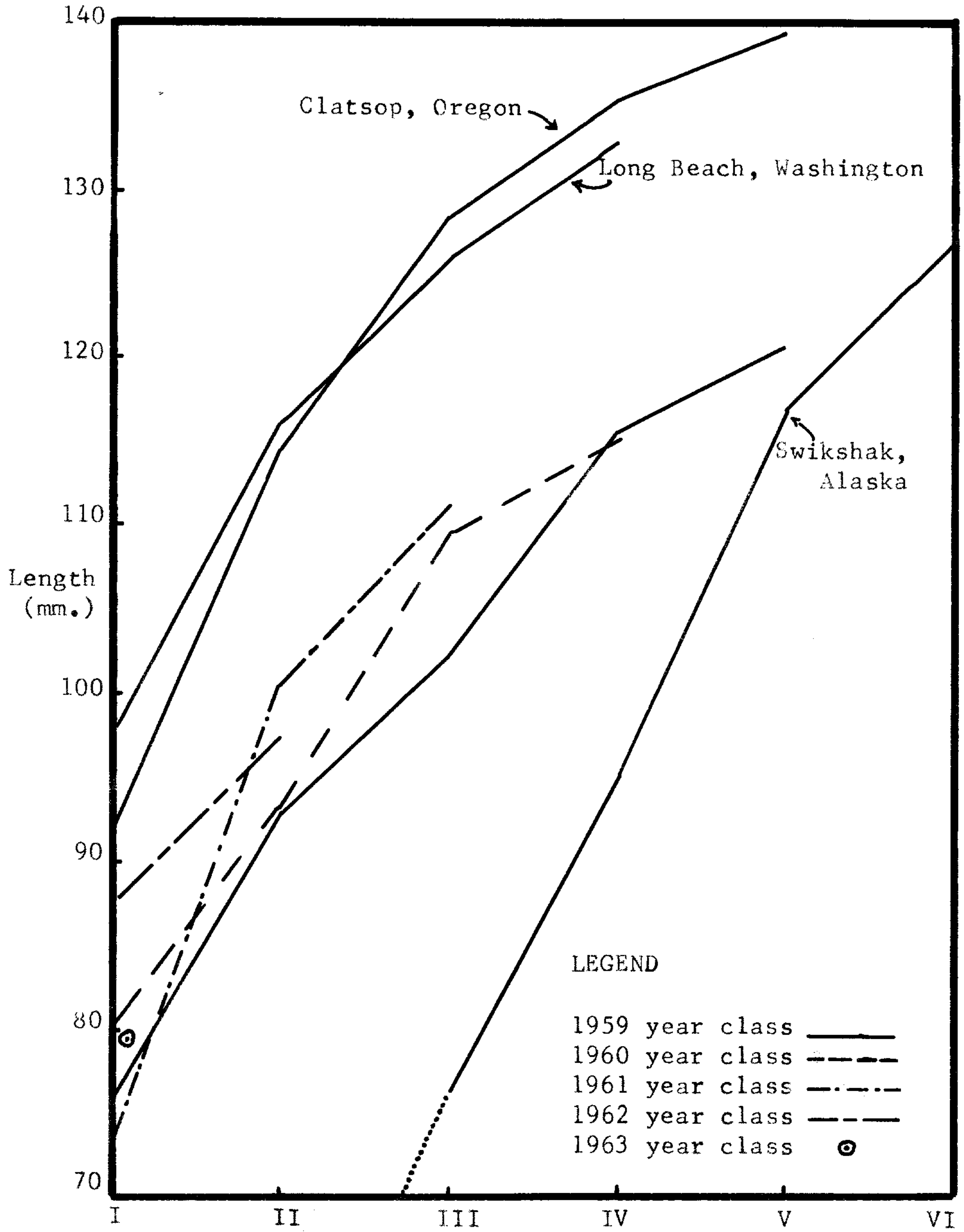

Figure 3. Growth curves for five age classes of Clam Gulch razor clams as compared with those of Washington (Tegelberg, 1964), Oregon (Hirschhorn, 1962), and Swikshak, Alaska (Weymouth, et al., 1925). Collected April, 1965.

Another confusing phenomenon in aging Alaskan razor clams is the presence of summer growth checks which are incorporated in the shell growth pattern. Some of these growth checks are not unlike winter annuli, and may be mistaken for the same. This worker found it impractical to attempt aging clams older than five years due to crowding of annuli and summer checks. The exact cause of false annulus formation is not known. However, many Cook Inlet beaches are underlain with gravel and clay which prevent razor clams from digging deeper than 12 - 18 inches. Possibly, extreme minus tides leave clams in a waterless environment for extended periods of time, thereby disrupting the shell growth patterns. Monthly collections of 1964 year class clams reveal that shell checks were formed during the first and last periods of July, 1965, which correspond to series of -5 foot tides.

Tegelberg (1964) reported that razor clams removed from the beach, held, marked and returned had formed false annuli (checks) prior to resuming growth.

REPRODUCTION

During the summer and early fall of 1965, periodic collections of razor clams were made at Clam Gulch. These clams were examined for sexual maturity so that the period of spawning and the minimum length of spawning clams could be determined. Weymouth, et. al. (1925) states that razor clams will spawn upon reaching a length of 100 mm. Spawning is thought to take place when the water temperature reaches 55° F. At Clam Gulch the water and sand temperatures were recorded at the times of collection. Water temperatures reached a maximum 55° F. between August 25-30, after which spawning was completed. Water and sand temperatures along with observations on spawning activity are presented in Table 3. Spawning and spawned clams are denoted by the appearance of their gonadal tissues. Those tissues, which had been firm as the sex products developed, were flaccid upon spawning with stringy connective tissue being very much in evidence. A later collection on September 24, 1965 revealed that the spawned clams had returned quickly to a firm condition.

Razor clam spawning activity was observed during late August and early September, 1965. Unseasonably cool weather and water is believed to have detained the spawning period, which is thought to normally occur in late July.

Table 3. Observations of razor clam spawning activity at Clam Gulch.

Area	Date 1965	Sand temperature °F	Water temperature °F	Collection data clams number	size range mm	Remarks
Clam Gulch	5/30	46.0	47.0	-	-	No spawning activity.
" "	6/30	52.0	54.0	67	85-144	" " "
" "	7/ 2	52.0	-	-	-	" " "
" "	7/29	52.5	59.0	-	-	" " "
" "	8/25	53.5	53.0	35	90-132	Spawning may have begun.
" "	8/30	55.0	65.0	12	86-125	One spawned clam.
" "	9/10	53.5	55.5	17	93-132	14 spawned, 3 mostly spawned. Spawned clams flaccid.
" "	9/24	50.5	50.0	16	96-128	All spawned. Clams are in good condition.

Clams of the 1963 year class were observed spawning. This may indicate that the reproductive potential of the Cook Inlet razor clam populations is greater than was once thought (Rearden and Weberg, 1959).

SIEVING FOR 1965 YEAR CLASS RAZOR CLAMS

Considerable amounts of Clam Gulch beach sand were washed through a fine mesh screen box on October 23 and December 9, 1965 to determine the success of the 1965 year class. Digging was done along the waterline at low tide. The upper five inches of sand from various locations was placed in the screen box and washed through. One clam of 15 mm length was collected in October. The sizes of the areas dug were not recorded, but a total of 2.5 digging and washing hours was conducted. The apparent low density of 1965 year class clams was rather alarming when compared with a strong year class of 77 newly set razor clams per square foot at Copalis Beach, Washington (Tegelberg, 1964). The possible failure of the 1965 year class may have been the result of late spawning. Young clams setting into the beach in early winter are subjected to freezing conditions from which they are unable to escape with their limited digging ability.

AVAILABILITY OF EASTERN COOK INLET RAZOR CLAMS

Razor clam age class composition, mean length of each age class and average clam size in a series of samples were studied. Seven age classes were represented in an April, 1965 collection of razor clams from Clam Gulch (Table 4). Age classes III - IV, larger than 100 mm were available to sport diggers at the time of digging. Age II clams were probably available to sport diggers in early summer, 1965.

Mean shell lengths were calculated for 14 razor clam collections from Cook Inlet during the spring of 1965 (Table 5). Mean individual lengths in the samples ranged from 112.2 - 131.8 mm. These means compare quite favorably with that from Clatsop Beach, Oregon (Twohy, 1949), where the mean size of all measured clams dug during the summer of 1949 was about 100 mm.

It was theorized that larger clams might be obtained during lower, low tides. The data presented in Table 5 are examined to test this. Present

Table 4. Size class composition of age classes for razor clams collected in April, 1965 at Clam Gulch.

Median of size interval mm	Age class - prior to 1965 growth I	II	III	IV	V	VI	VII	Number
75.5	2							2
79.5	3	1						4
83.5	1	1						2
87.5		2						2
91.5		3	1					4
95.5		2	2					4
99.5		1	3					4
103.5			6	2				8
107.5			5	4	1			10
111.5			2	5	2			9
115.5			1	8	1			10
119.5				7	3	1		11
123.5			1	2	7	2		12
127.5							2	2
131.5								
135.5						1		1
Total No.	6	10	21	28	14	4	2	85
Percent	7.0	11.8	24.7	32.9	16.5	4.8	2.3	
Ave. length	78.83	90.30	104.83	114.36	119.21	125.50	127.50	

Table 5. Sample means of razor clams collected near the Clam Gulch beach access and oil pad roads and Deep Creek area.

Location	Date 1964	Sample Size	Mean Clam Length mm.	Tide Level ft.
Clam Gulch	4/15	53	112.2	-2.8
" "	4/18	26	117.3	-3.1
" "	4/18	79	114.4	-3.1
" "	5/ 3	125	116.9	-4.5
" "	5/ 6	34	120.7	-1.1
" "	5/13	58	117.9	-1.7
" "	6/ 2	18	116.7	-4.4
" "	6/29	31	115.9	-5.0
Oil Pad	6/ 1	61	124.9	-5.0
" "	6/29	23	117.3	-5.0
" "	6/29	67	122.3	-5.0
Deep Creek	5/16	57	131.8	-3.2
" "	5/31	50	119.7	-4.9
" "	6/ 1	55	118.1	-5.0

data appear not to support the assumption. One sample collected at Clam Gulch on a -1.1 foot tide averaged 120.7 mm in length. After two additional months' growth, clams of 115.9 mm mean length were collected on a -5.0 foot tide from the same general area. Other data in Table 5 also indicate that the size distribution of razor clams on Cook Inlet beaches appears not to be related to the tide level at which they become exposed.

SUMMARY

Razor clams are found in harvestable numbers between the Kasilof River and Happy Valley along the Cook Inlet coast of the Kenai Peninsula. The best digging area is at Clam Gulch, 22 miles south of Soldotna. Deep Creek beaches, 45 miles south of Soldotna, are also favorites of clam diggers. Razor clam studies were conducted at these beaches during 1965.

The life cycle of razor clams from conception to first spawning will probably be completed in three years. Mature clams usually spawn in mid-summer when the water temperature reaches 55° F. Young clams are ciliated, and swim for 5-16 weeks before developing a shell and setting into the beach. Larval clams grow slowly through the late fall months, possibly discontinue growth during the midwinter months, grow slowly during the early spring months, and display more rapid growth during the summer months. Young of the year clams were located at Clam Gulch in April, 1965. Two size groups displayed means of about 30 and 47 mm. The largest of these groups averaged nearly 80 mm in length by the end of their first complete summer of life. Clams experience rapid growth during their second growing season and may measure 100 mm in length at the second annulus. Growth then slows, with length increases of 10 mm or less being obtained through the following years.

Aging razor clams is difficult because of summer growth checks (false annuli) which, it is felt, are caused by disturbed growth through tidal action.

Razor clams along Cook Inlet spawned very late in 1965, with the most activity being observed in early September. Unseasonable weather detained the warming of Cook Inlet waters. Young clams probably did not set until late fall, and during low tides may have been subjected to exposure and freezing. Sluicing beach sand through a screen box to collect young of the year razor clams was performed in October and December, 1965. Only one small clam was collected in October at Clam Gulch.

Analysis of a sample of razor clams collected in April, 1965 revealed that age II individuals may enter the fishery while still in their second full year of growth. Age III clams averaged over 100 mm in length and comprised 24.7 percent of the sample, indicating entrance into the fishery at a younger age than was imagined.

Fourteen samples collected along Cook Inlet during the spring of 1965 contained a total of 575 razor clams. Mean lengths of the samples ranged from about 112-132 mm as compared to a grand average size of about 100 mm for all Clatsop Beach, Oregon clams collected by sport diggers in 1949.

Razor clams may be obtained on any minus tide at Clam Gulch and on -2 foot tides at Deep Creek and the southern Cook Inlet beaches. Lower tide levels do not necessarily produce larger clams at Clam Gulch and Deep Creek even though clams located at the -1 foot tide level are more susceptible to digging pressure than those found at the -5 foot tide level.

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